Technical Memorandum No. 33-58

ALPS

Advanced Liquid Propulsion Systems

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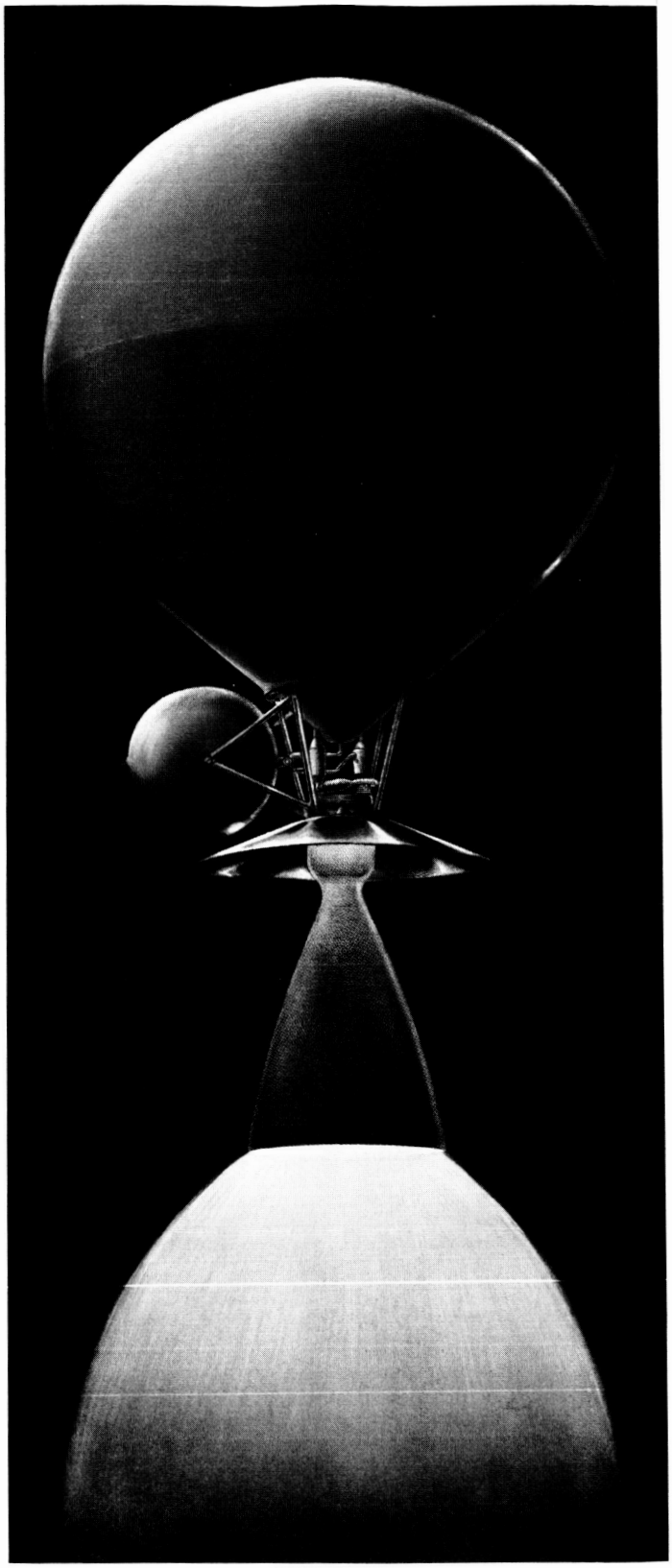


ALPS Propulsion System

I. THE ALPS PROGRAM—Advanced Liquid Propulsion Systems

The Jet Propulsion Laboratory's ALPS program was established to solve critical problems in spacecraft propulsion. These problems have been created by the complexity of the missions planned for the near future (1965–70). Dependable, high-performance midcourse propulsion units, retro-rockets, and return launch rockets must be available to perform these missions. Present-day technology is inadequate to provide the required systems. Success of the propulsion operations can be assured only by advancement of the technology. The ALPS program is designed to accomplish this advancement in the state-of-the-art.

A basic liquid rocket system has been devised which will be used to demonstrate the validity of the concepts developed during the ALPS program. Tests of a complete system are necessary to assure that all of the concepts are mutually compatible. Artists' sketches of the several subsystems (see Fig. 2-4), as they might appear in the prototype, are presented on the following pages. This basic ALPS system is a simple but extremely versatile bipropellant rocket. This basic system can perform midcourse correction maneuvers, a final retro maneuver (into orbit or soft landing with hovering), and return launch. In addition, the basic system can supply pressurized cold gas, hot gas, monopropellant, or a bipropellant combination for use in attitude control or propulsion system separation. Most of the concepts used in the system have been tested at JPL in one form or another. The unique arrangement of the component parts forms a liquid rocket which will have the characteristics enumerated in Table 1.

Table 1. ALPS characteristics

1. Earth and space storable with minimum insulation requirements (design objective of one year storage at +40 to +100°F).
2. "Zero-*g*" startable (design objective of ten starts under 0 to 1 *g* acceleration in any direction).
3. Throttleable (design objective of 10 to 1 thrust range with rapid and reproducible thrust transients).
4. Dependable (design objective of 98% certainty, at launch, of operation within design tolerances).
5. High performance (design objective of 324 sec specific impulse at 40 to 1 expansion ratio and chamber pressure of 150 psia with nitrogen tetroxide and hydrazine in a propulsion system with a mass ratio of 0.91 when burning time at rated thrust is 250 sec).
6. Scalable (design objective of 1,000 to 40,000 lb rated thrust).

ALPS SCHEMATIC DIAGRAM

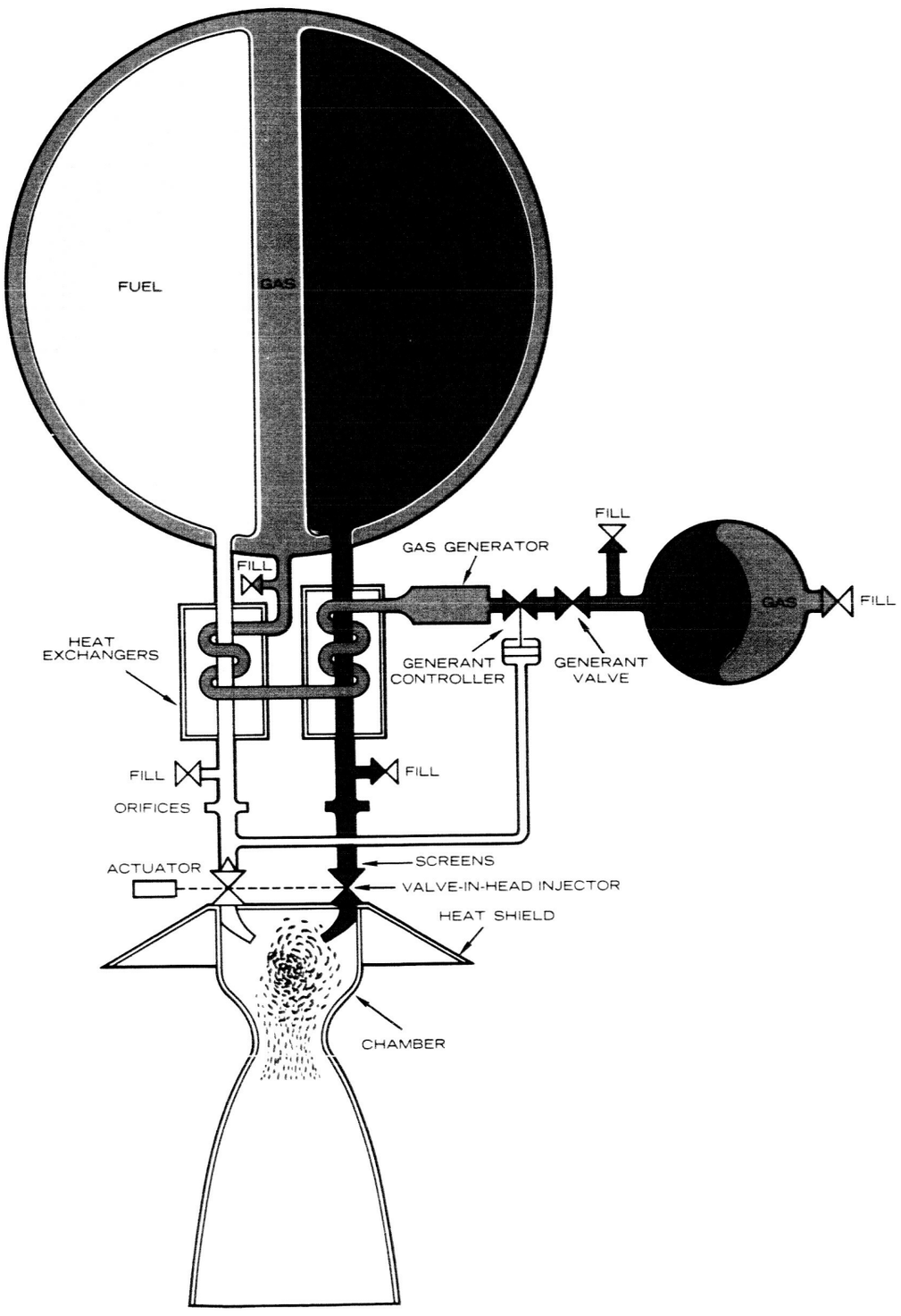


Figure 1

ALPS ENGINE SUBSYSTEM

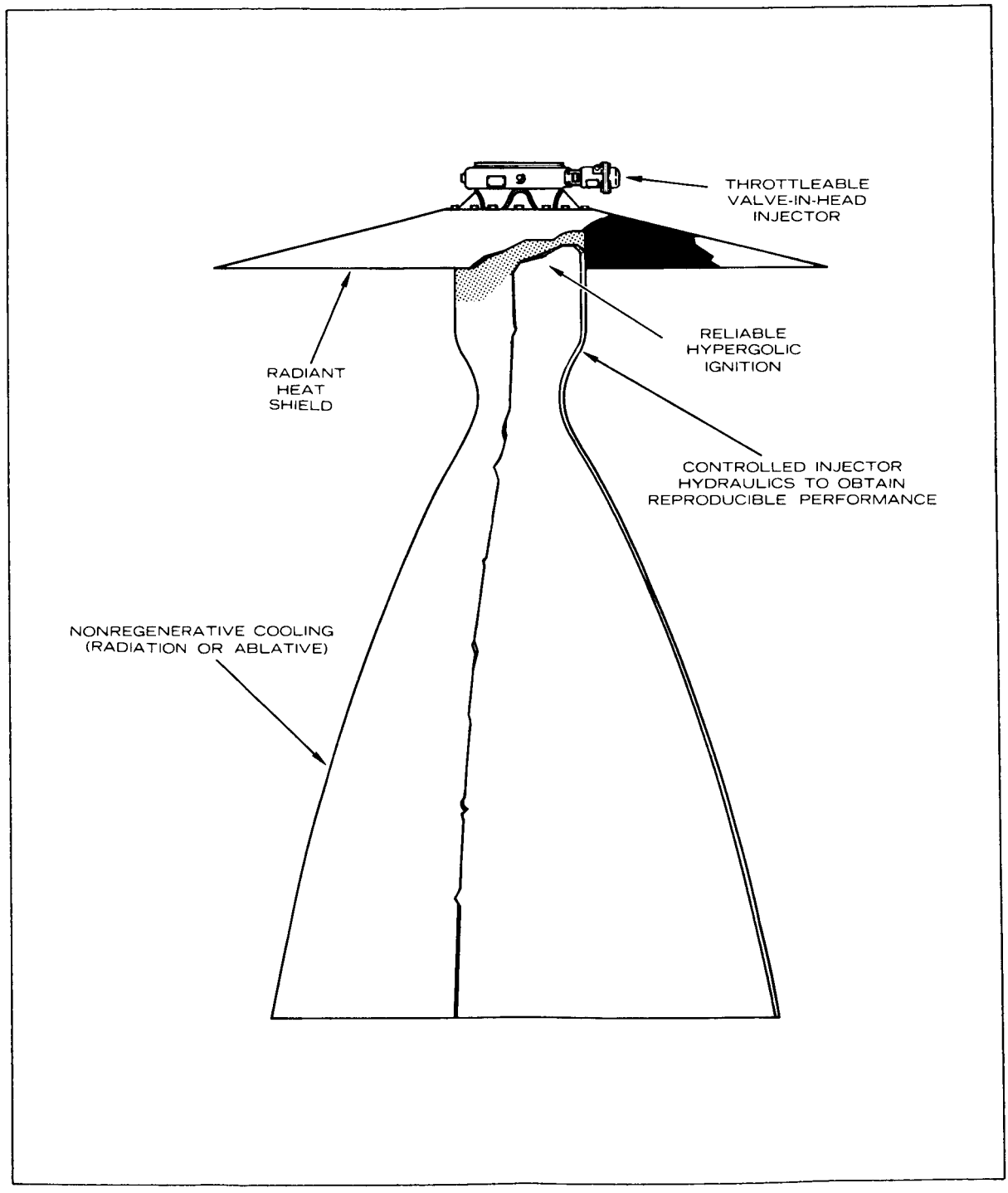


Figure 2

ALPS PROPELLANT STORAGE SUBSYSTEM

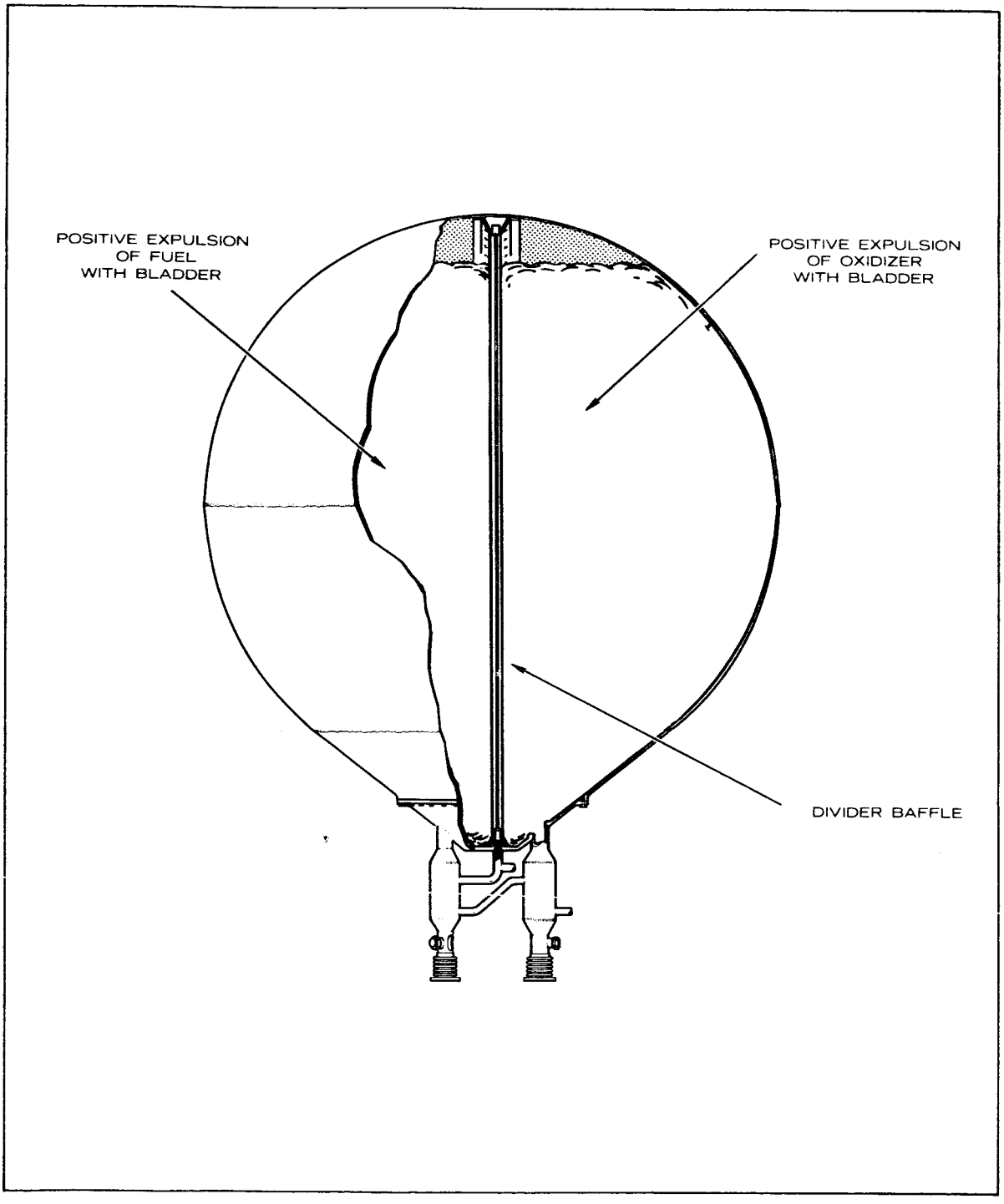


Figure 3

ALPS GAS GENERATION SUBSYSTEM

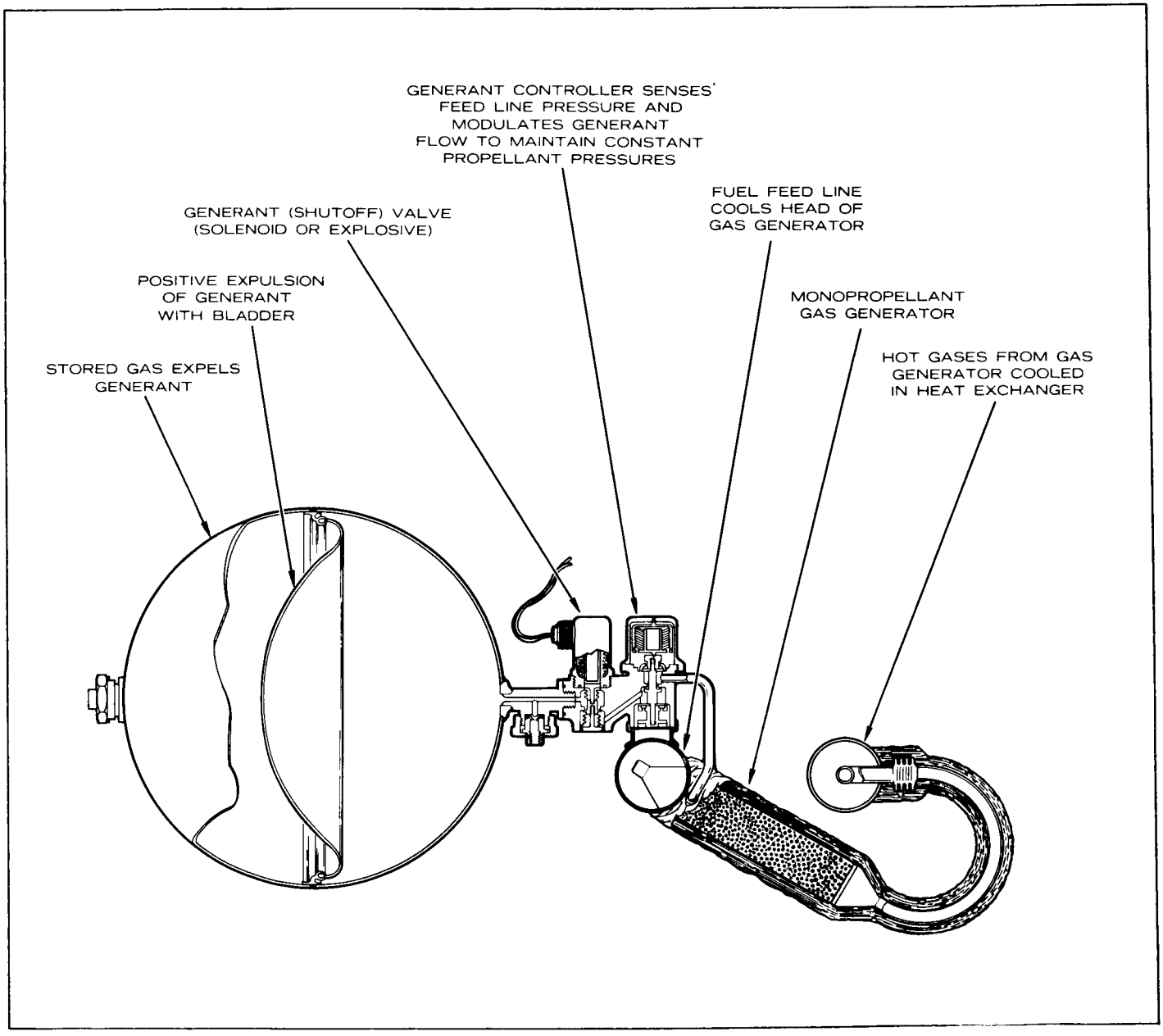


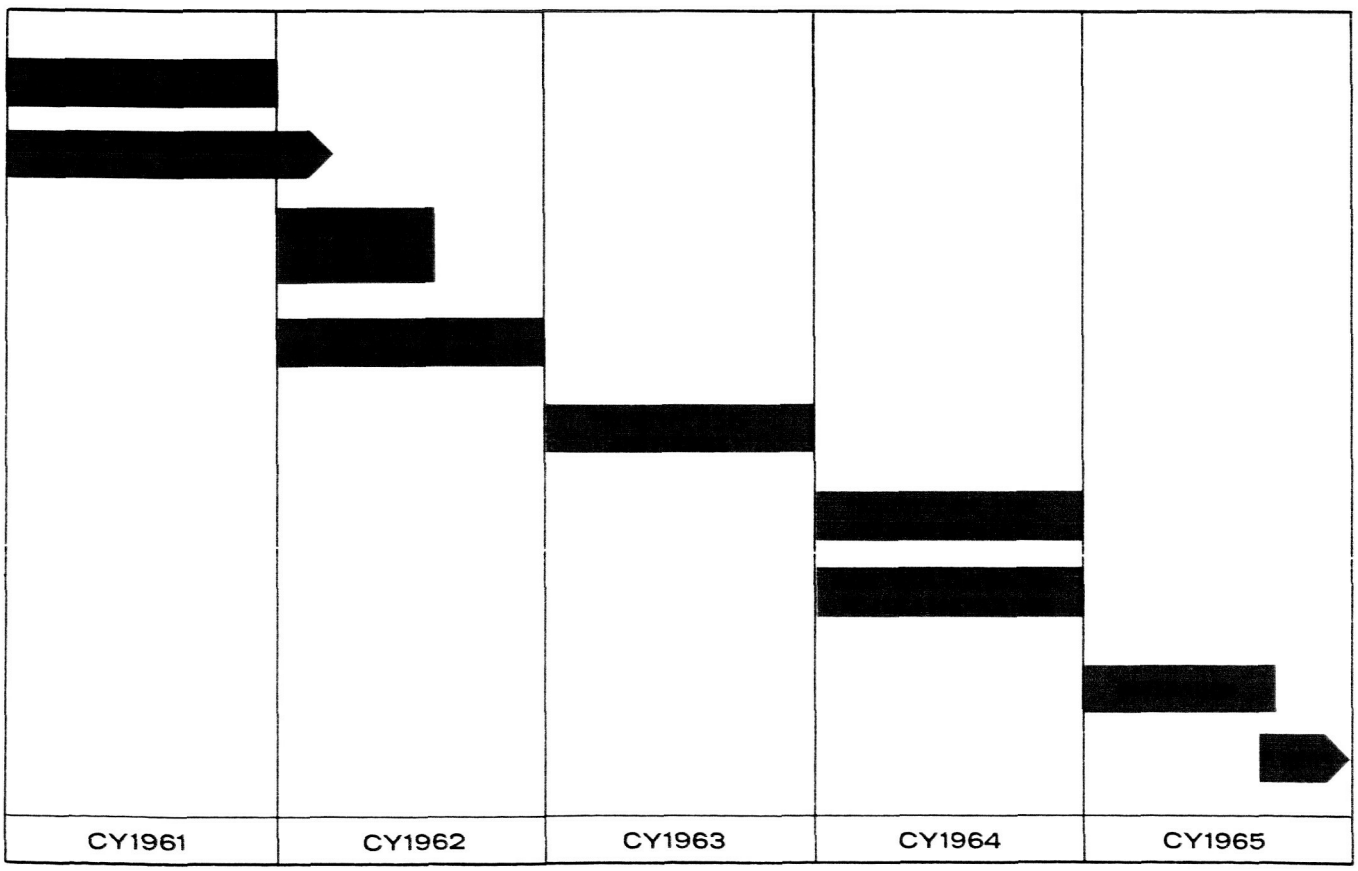
Figure 4

II. ALPS SCHEDULE

The ALPS schedule (Table 2) has been arranged to permit demonstration of the prototype system in calendar year 1963. During 1964, a year-long storage test followed by additional firings is planned. Successful completion of this schedule will allow fabrication of flight units by industrial contractors for the missions starting in 1965.

Past experience has shown that the engineering technology must be available prior to initiation of flight programs if early success is to be assured. This schedule provides sufficient time for an orderly, thorough approach to the work of providing an advanced technology in liquid rocket propulsion.

Table 2. ALPS schedule



III. ALPS ADVANCEMENTS IN THE STATE-OF-THE-ART

While producing the technology required for the ALPS system, the specialized analytical and experimental tasks are expected to yield valuable advancements in the state-of-the-art of liquid propellant rocketry in these areas:

1. Radiatively cooled thrust chambers.
2. Throttleable propellant injectors.
3. Propellant expulsion bladders.
4. Gas generators.
5. Valve design.
6. Materials compatibility.
7. Over-all propulsion system integration.